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An ATC Simulation Platform based Compass Satellite Navigation System

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Abstract

Based real-time, high precision characteristics of satellite navigation system, the aircraft in flight can be continuous and accurate positioned its location. Therefore the interval width of en-route and the interval separation could be reduced. And the reduced flight time, the increased flights, and the high utilization of airspace could meet the development of airline transportation. Thus the free flight could be achieved in near future. The compass satellite navigation system is established by the Chinese regional navigation and positioning system. The system could provide users around the clock, the clock real-time location services, short message service and precision timing services. According to the compass satellite navigation system, an air traffic control simulation platform based compass satellite navigation system has been proposed in this paper. The structure, functions and the future research fields have been introduced in detail. The research of this paper plays an important role to impel applications of air traffic management based compass navigation satellite system.

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Keywords: compass satellite navigation system; air traffic control; simulation platform

1. Introduction

Satellite navigation system have such characteristics of real-time and high precision which can make the aircraft continuously and accurately locate itself, reduce the interval width of routes and height

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partition. At the same time the flight time can be reduced and the airspace utilization and the flight density can be increased greatly. Thus the free flight can be achieved finally. With the transfer from the radio navigation to satellite navigation in air traffic control named ATC, the research of ATC Simulation platform based on satellite navigation systems has important significance.

From the initial view of the simulation of air traffic control system, the main air traffic control simulation is for a specific air traffic control needs, using a single simulation system simulation and applying the methods of discrete Modeling and Simulation. With the development of the ATC system, the demand for simulation technology gradually from a single simulation experiment extended to the full-size model of the running simulation, the simulation technology used in simulation saw the transition from single to distributed systems simulation. The X-ATASim system and Sky's ISENA-Interactive Simulator for EN-route and Approach System and ISTAG-Interactive Simulator for Tower, Apron and Ground System have been approached. The ComDATSS for air traffic control system was design and automation tools. A real-time simulation system Air-Ground Integration Experiment has been developed and the system can achieve real-time simulation. Advanced Aviation System Development (CAASD) has developed a simulation system for ATM :Aviation SimNet, the system has characteristics such as open, multi-network interconnection aiming at integrated simulation, on behalf of the direction of the development of air traffic control simulation system. And the fast simulation platform simulation experimental platform was researched for improving the development of European air traffic management technologies play an important role. The Airport and Airspace Simulation Model developed (Airport and Airspace Simulation Model, SIMMOD), is a simulation model aiming at airports and airspaces. Besides these, aviation managing simulation and performance estimation based on GNSS was approached. A future satellite navigation system architecture system performance has been developed. Simulation of the passive regional satellite navigation system based on HLA and Simulation and Evaluation the performance of the Proposed Constellation of Global Navigation Satellite System have been carried out to improve the level of the application of satellite system.

As can be seen from the above studies, at home and abroad from the simulation platform, simulation models, etc. to carry out a series of studies, but because of restrictions of the computer technology by the time, the study of the fidelity of flight simulation is in low degree, the air traffic simulation process is not good, and domestic research program is currently limited to the research work of ATM under the radar and procedure control. The studies of under way for satellite-based navigation and air traffic management related to model application simulation platform are also rarely involved.

Compass satellite navigation system is the satellite navigation system that developed in China, self construction, self-management, with completely independent intellectual property rights of ,which can provide users around the clock, the clock real-time location services, short message service and precision timing, the Design specifications and features meet or better than the current GPS, GLONASS and other primary satellite navigation system. This paper provides air traffic control simulation platform that's functions based on the proposed satellite-based navigation system, introduces the simulation platform architecture, function and future of applied research as well as describes China's compass satellite navigation system. The research is important to the promotion of the application of compass satellite navigation system in the National Air Traffic Management system. And it is meaningful to improve the level of the research airworthiness of civil aviation.

2. Introduction of compass navigation satellite system

2.1. Structure of compass navigation satellite system

Compass navigation satellite system and the U.S. GPS, the Russian Glonass, Galileo and the European Union are the world's four major satellite navigation system. It has played an important role in our country's aerospace, aviation, marine, transportation, electricity, finance, petroleum, geology, agriculture, surveying, geophysics, water conservancy, fishery, forest fire monitoring and national security and many other fields. The compass navigation satellite system structure that based on double-star positioning shows in Fig.1.

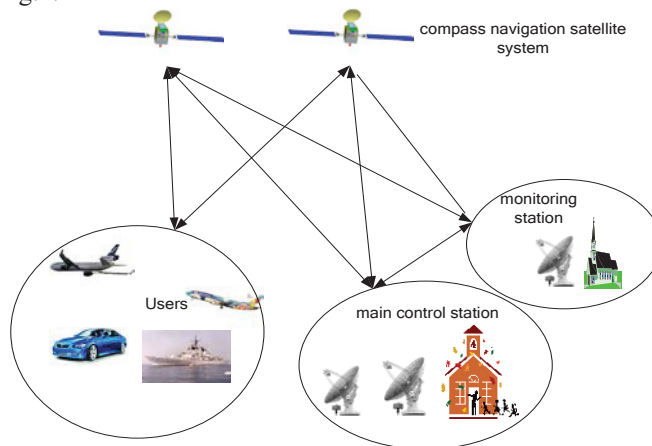


Fig.1. The structure of compass navigation satellite system

Compass navigation satellite system consists of three parts that are the end of space, ground-side and client-side. Space-side includes 5 geostationary satellites and 30 non-geostationary orbit satellites. Ground-side includes master control station, transfused station, monitoring station and a number of ground stations. User's part consists of several compatible terminals, which include Compass user terminal and the U.S. GPS, the Russian GLONASS (GLONASS), the European Galileo (GALILEO) and other satellite navigation system.

2.2. Function of compass navigation satellite system

Compared with other satellite navigation systems, compass navigation satellite system has positioning and communication function at the same time with no other communication systems' supporting. Its range can cover China and neighboring countries and regions for 24 hours per day, no blind communication area. Particularly the compass navigation satellite system is suited for monitoring and managing a large range area for group users. With unique central node-type and command-based design, compass navigation satellite system can solve such questions quickly and freely as "Where am I?" and "Where are you?". At the same time, the compass navigation satellite system is an autonomous system with design of high Encryption strength, safety, reliable, stable and suitable for applications which is suited in many secret and key departments.

As is known the compass satellite navigation system has three main functions, namely precise positioning, short-message communication and precision timing separately. All of them are described as follows,

- **Precise positioning**

As is introduced in many fields the compass navigation satellite system can identify the location of customer and applier quickly, and the compass navigation satellite system can provide navigation

information for users and authorities. In the coverage area of calibration station, it is a remarkable that the difference of positioning accuracy can reach 20 meters. And in the coverage area of nor-calibration station, the difference of positioning accuracy is no more than 100 meters. Therefore that is a great progress for the compass navigation satellite system.

● **short-message communication**

Besides the precise positioning, the compass navigation satellite system has a special and unique function that no more than 120 characters of Chinese short-message could be communicated with dual-way communication between the user and user, the user and the central control system. With the same meaning the compass navigation satellite system could be realized the communication with the mobile interoperable communications systems and internet through the gateway stations.

● **Precision timing**

The third main function of the compass navigation satellite system is the precision timing. The timing information is broadcasted regularly by the central control system. Therefore the delay-correction-difference could be updated and applied to users as quickly as possible. Two models of timing for users could be obtained, named regular one-way timing and dual-way timing. The difference of regular one-way timing accuracy could be achieved 100ns, and the difference of dual-way timing accuracy will be 20ns.

3. Air traffic control simulation platform based satellite-based navigation system

3.1. Architecture of Simulation Platform

Compass satellite navigation system's air traffic control simulation platform is a Control Simulation and Simulation System which include hierarchical deployment and interactive simulation. The simulation platform is based on three major functional simulation models: location, timing, short message, and simulation models: navigation, communications, surveillance and other performance required, all of those are provided by Compass satellite navigation system. It can also provide information integration about the control module and the flight model. So as to provide technical and theoretical support for air traffic control application based on satellite-based navigation. Satellite-based navigation system, air traffic control simulation platform architecture shown in Fig.2:

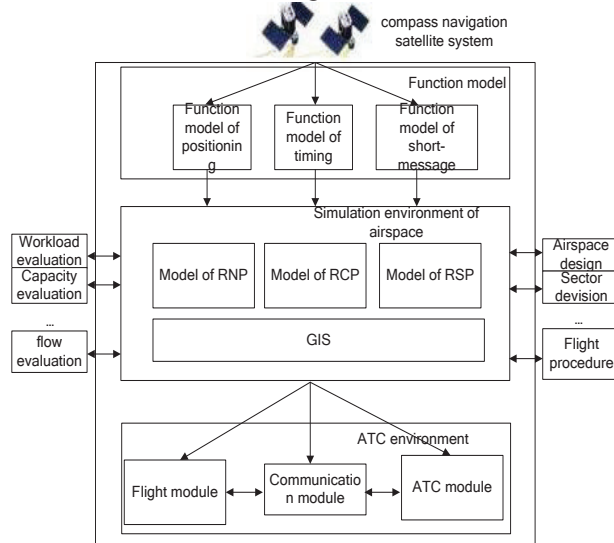


Fig.2 The ATC simulation platform

Air traffic control simulation platform based on Satellite-based navigation system has a total of three layers, namely, the function simulation model, airspace simulation environment and air traffic control environment.

As is shown in figure 2, the function simulation model is to achieve Compass navigation satellite system's three functional simulation models: function model of positioning, function model of timing, and function model of short message. All of them realize the research on the system's three functional models. The simulation environment Airspace, including the total system performance models, model of RNP(requirement navigation performance), model of RCP(requirement communication performance), and model of RSP(requirement surveillance performance). And airspace's running simulation is composed of airspace design, sector division, flight procedure, workload evaluation capacity evaluation, flow evaluation, etc.).Air traffic control environment, including the flight module, communication module and ATC module, is to achieve data and communication integration between pilot and controller.

3.2. Research content of simulation platform

Based on compass navigation satellite system of air traffic control simulation platform can run fast simulation of air traffic, air traffic flow simulation of the operation in the airspace, verify compass satellite navigation system the new generation of air traffic management concepts. ATC simulation platform in this, you can of air traffic management issues in the simulation, such as workload assessment, assessment of airport capacity, airport procedures reasonably designed or optimized program assessment, air traffic flow management solutions to assess the rationality, conflict detection and resolution of problems, scheduling problems the approach and departure, route and route restructuring, control and adjustment of designated sectors, and regional navigation area navigation route airspace validation and evaluation, the setting of parallel routes, RVSM and other issues. Its main contents include:

- Flight Simulation

Satellite-based air traffic control navigation system simulation platform for flight simulation can be achieved. The main response of the aircraft behavior and its instructions, the aircraft positioning accuracy in the environment of the satellite flight track and bias, while including an aircraft, between aircraft and ground surveillance simulated.

- The simulation of the open space

Members can and controller of aircraft data communication between the simulation studies based on the compass navigation satellite system short message communications in air traffic control in the practical application.

- ATC Simulation

Satellite-based air traffic control navigation system simulation platform controller can control simulation, including process control, radar control, tower control, scene control and other control methods to run under the control of the environment simulation.

- Airspace environment simulation

Satellite-based air traffic control navigation system simulation platform enables the simulation of airspace and its environment to achieve the terrain, location points, route / routes, approach and departure procedures, navigation aids, meteorological simulation environment.

- Aeronautical Information Management Simulation

Satellite-based air traffic control navigation system simulation platform for information generation and dissemination of AIS achieved so simulation.

- Air Traffic Management Simulation

Satellite-based air traffic control navigation system simulation platform enables carriers to direct simulation and operation management, and simulation of air traffic flow management.

4. Conclusion

Compass satellite navigation system is established by the Chinese regional navigation and positioning system, to provide users around the clock, the clock real-time location services, short message service and precision timing services. In this paper, on compass" navigation satellite system composition and function of the system, based on the proposed satellite-based air traffic control navigation system simulation platform architecture. Describes the simulation platform architecture, function and future of applied research, the research for the promotion of compass navigation satellite system in our application of the National Air Traffic Management system is important. And it is meaningful to improve the level of the research airworthiness of civil aviation.

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References

- [1] Gatersleben .M.R, Simon.W.W. Analysis and Simulation of Pas-senger flows in an Airport Terminal [C]. In Proceedings of the 31st Conference on Winter Simulation, Phoenix, Arizona, United States, 1999, pp. 1226-1231
- [2] Niu.F, Gao.W.G, Li C.X. Research on aviation managing simulation and performance estimation based on GNSS[J]. GNSS world of china. 2007, 32(5), pp.1-4
- [3] Beck.T, Trautenberg.H.L., Soualle. F, *et al.* Future satellite navigation system architecture system performance[C]. Institute of Navigation - International Technical Meeting 2010, San Diego, United states, 2010, pp. 1157-1171
- [4] Ralph.W, Rissmiller.J. Overview of GPS certification for commercial and general aviation[C] IN: Biennial Flight Test Conference, 7th, Colorado Springs, CO, June 20-23, 1994, American Institute of Aeronautics and Astronautics pp.162-169
- [5] Zhao C.M, Ou J.K, Yuan Y.B. Positioning Accuracy and Reliability of GALILEO, Integrated GPS—GALILEO System based on Single Positioning Model[J]. Chinese Science Bulletin. 2005, 50(12), pp.1252-1260.
- [6] Werner.W, Zink.T, Hahn.J. Galileo Integrity Performance Assessment , Results and Recommendations[C]. ION GPS/GNSS , Portland ,2002, The Institute of Navigation. pp. 2185-2195
- [7] Liu.G.M, Liao.Y, Wen.Y.L, *et al.* Simulation and Evaluation the performance of the Proposed Constellation of Global Navigation Satellite System[C]. AsiaSim, 2007, (CCIS 5. 2007), pp.103-111.
- [8] Liao.Y, Pan.W.H, Yang.X.R, *et al.* Simulation of the passive regional satellite navigation system based on HLA[C]. Tenth International Conference on Computer Modeling and Simulation, 2008, pp.416-421.